

Chapter 2

A Beaconless Minimum Interference Based Routing Protocol to Minimize End-to-End Delay per Packet for Mobile Ad hoc Networks

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ABSTRACT

The authors propose a beaconless, on-demand, mobile ad hoc network routing protocol called minimum interference based routing protocol (MIF) that minimizes the end-to-end delay per data packet. During route discovery, each node inserts its identification and location information before broadcasting the Route-Request (RREQ) message in its neighborhood. The weight of a link, called the interference index, is the number of interfering links surrounding it. Two links are said to interfere with each other, if the distance between the mid points of the two links is within the interference range. The interference index of a path is the sum of the interference index values of the constituent links. The destination selects the path with the minimum interference index value and notifies the source through the Route-Reply packet. Simulation results demonstrate that MIF incurs a significant reduction in the end-to-end delay per data packet vis-à-vis the interference-aware load balancing routing protocol.

DOI: 10.4018/978-1-4666-0050-8.ch002

INTRODUCTION

A mobile ad hoc network (MANET) is a dynamic distributed system of wireless nodes that move independent of each other. The nodes operate with a limited battery charge and as a result have a limited transmission range per hop. Routes in MANETs are often multi-hop in nature; thus each node is capable of serving both as a forwarding node as well as a source/destination of a data communication session. MANET routing protocols are of two types: proactive vs. reactive. The proactive routing protocols predetermine routes for every possible source-destination pair irrespective of the requirement. The reactive routing protocols determine a route from a source to destination only when required. In dynamically changing mobile environments, reactive on-demand routing incurs significantly less overhead than proactive routing. Hence, we restrict ourselves to reactive routing protocols for the rest of this paper.

Wireless networks are prone to interference. The medium is shared and there is no dedicated wire connecting any two nodes in the network. For theoretical purposes, we assume that two nodes are connected by a link if the distance between the two nodes is less than or equal to the transmission range. In reality, the strength of an electrical signal attenuates with distance. The coverage area for a node thus depends on the maximum transmission power set up at the node. Hence, for all practical purposes, in order to say that a receiver node is within the transmission range of a transmitter node, the transmission power at the transmitter node should be set up in such a way that the signal-to-interference-noise-ratio ($SINR$) of the attenuated signal reaching the intended receiver node is at least of certain threshold strength quantified by the minimum signal-to-interference-noise-ratio ($SINR_{min}$). If the signal strength gets deteriorated beyond the recognizable threshold value, then a node normally discards the signal received.

Interference between the radio signals significantly influences the throughput of wireless ad

hoc networks. With multi-hop routing so common in MANETs, interference-aware routing is essential for these networks. The strength of the signal received at a node is the sum of the strength of the attenuated signals transmitted from nodes that are within the neighborhood of the receiver node. Two signals are said to interfere with each other, if the sum of their $SINRs$ is appreciably different from their individual $SINRs$. Thus, signals of two nodes that are not within the transmission range of each other can still interfere with each other. Jain et al. (2003) modeled the interference between neighboring nodes using a conflict graph which indicates the group of links that mutually interfere and cannot be active simultaneously. Performance studies suggest that the network throughput can be significantly improved by modeling the network as a conflict graph and employing an interference-aware routing protocol based on the conflict graphs.

In this paper, we propose an on-demand routing protocol called Minimum Interference (MIF) based routing protocol that makes use of the conflict-graph modeling for ad hoc networks. According to this model, two links are said to interfere (or conflict) with each other, if the distance between the mid-points of these links is less than or equal to a parameter called the *Interference Range per Link* (IRL). MIF works as follows: When the source does not have a path to the destination node, the source broadcasts a Route Request (RREQ) message throughout the network. Each intermediate node, upon receiving the RREQ message for the first time, will include its location and identification information in the RREQ message before broadcasting the message in its neighborhood. The destination receives several RREQ messages, each of them having traversed over a different path. The destination constructs a weighted graph, called the interference graph, in which the vertices of the graph represents the nodes in the network and there is an edge (i.e., link) between any two vertices, if the Euclidean distance between the two vertices is less than or equal to

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